(12) UK Patent Application (19) GB (11) 2 403 365 (13) A

(43) Date of A Publication 29.12.2004

(21) Application No: 0314968.9

(22) Date of Filing: 27.06.2003

(71) Applicant(s):
Hewlett-Packard Development Company L.P.
20555 S.H.249, Houston, Texas 77070,
United States of America

(72) Inventor(s):
Maurizio Pilu

(74) Agent and/or Address for Service:
Bruce G R Jones
Hewlett-Packard Ltd, IP Section,
Stoke Gifford, BRISTOL, BS34 8QZ,
United Kingdom

(51) INT CL[7]:
H04N 5/232

(52) UK CL (Edition W):
H4F FAAP FCCX FDX

(56) Documents Cited:
WO 2003/009074 A1 WO 2002/041273 A1
US 20020086271 A1

(58) Field of Search:
UK CL (Edition V) H4F
INT CL[7] H04N
Other: WPI, EPODOC, JAPIO, INSPEC

(54) Abstract Title: **Camera having behaviour memory**

(57) A portable camera 2 includes a behaviour memory 14 that stores data used to control the camera 2 using processor 10. The camera or other portable imaging device can control automatic image capture using rules stored in behaviour memory 14, and these rules or behaviours may be downloaded when the camera is near a beacon (44, Figure 2), or behaviours may be modified by a learning process involving the camera user. As also shown in Figure 2, camera 2 may be wearable. Behaviours or operational rules controlling the camera may be stored in a base station or device remote from the camera having a behaviour library, repository or server. New or modified camera behaviours may be used as a response to camera position as sensed by a GPS system. In general, the control of the camera according to certain behaviours or rules ensures that appropriate images are captured in different situations; for example, if the camera senses the user is mountaineering, the behaviours may specify that panoramic views are preferred. Similarly, if the camera is at a sporting event such as a tennis match, different behaviours or parameters may be applied, e.g. the flash may be inhibited, and only the region of play or interest may be imaged.

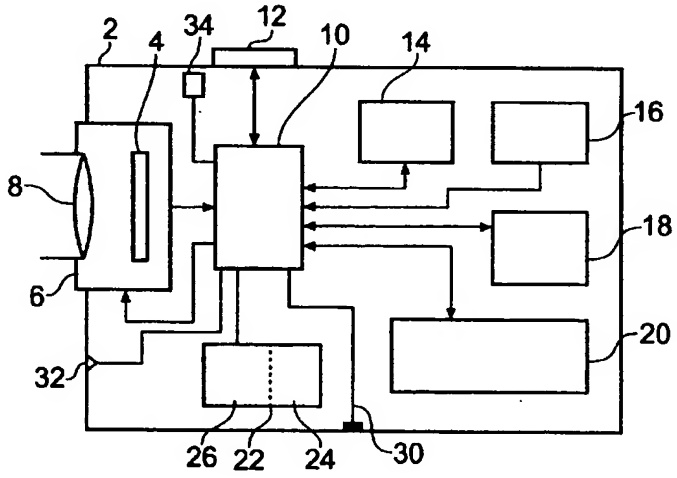

Fig. 1

GB 2 403 365 A

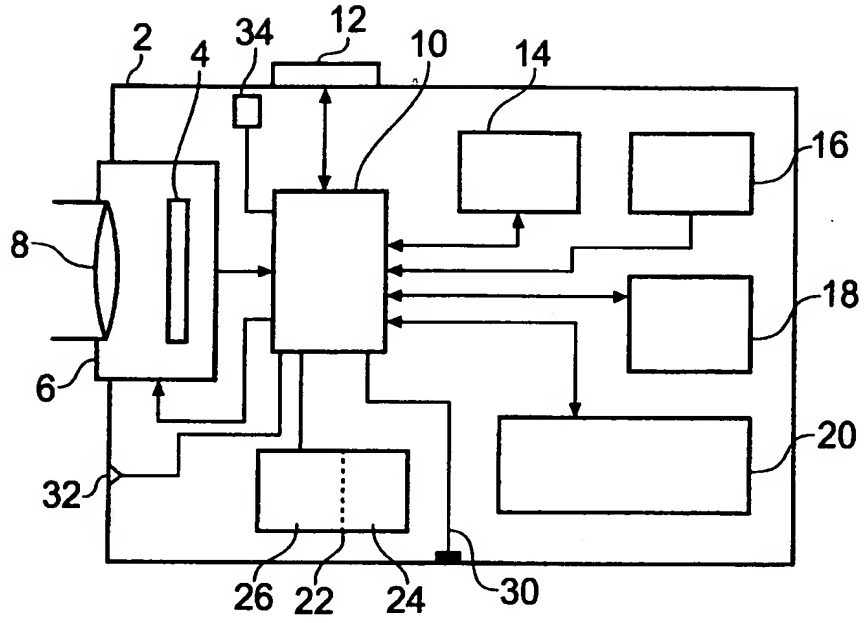

Fig. 1

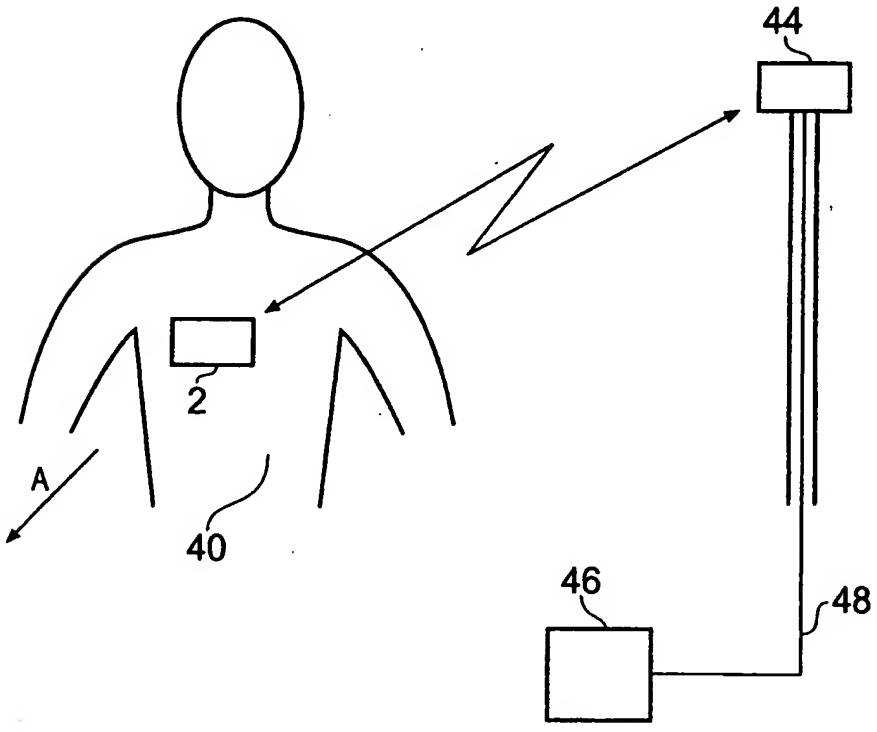

Fig. 2

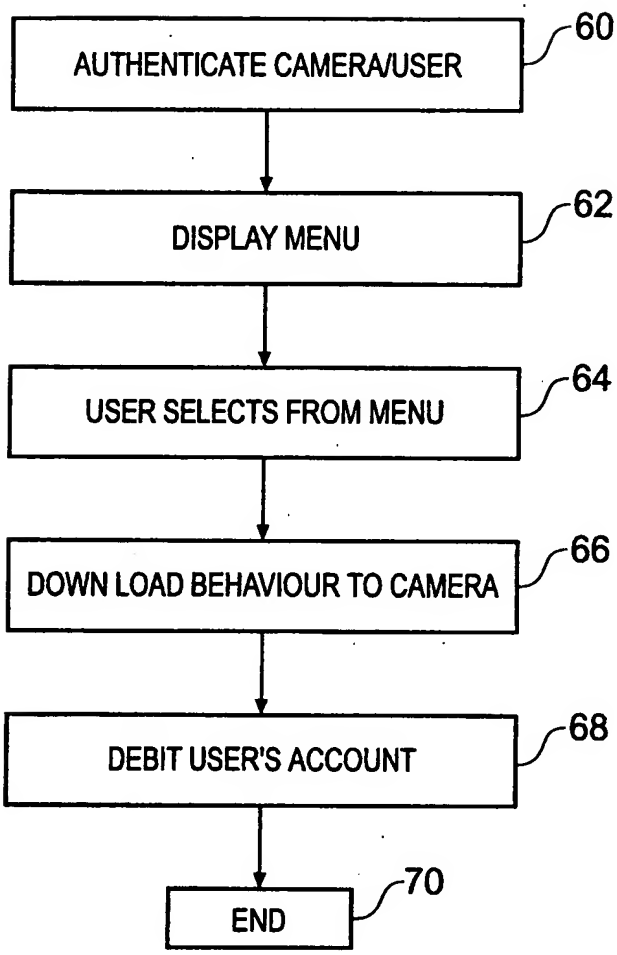
AUTHENTICATE CAMERA/USER
60
DISPLAY MENU
62
USER SELECTS FROM MENU
64
DOWN LOAD BEHAVIOUR TO CAMERA
66
DEBIT USER'S ACCOUNT
68
END
70

Fig. 3

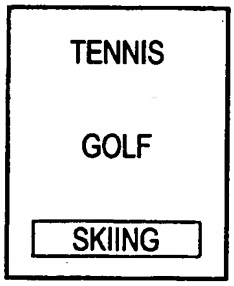
TENNIS
GOLF
SKIING

Fig. 4

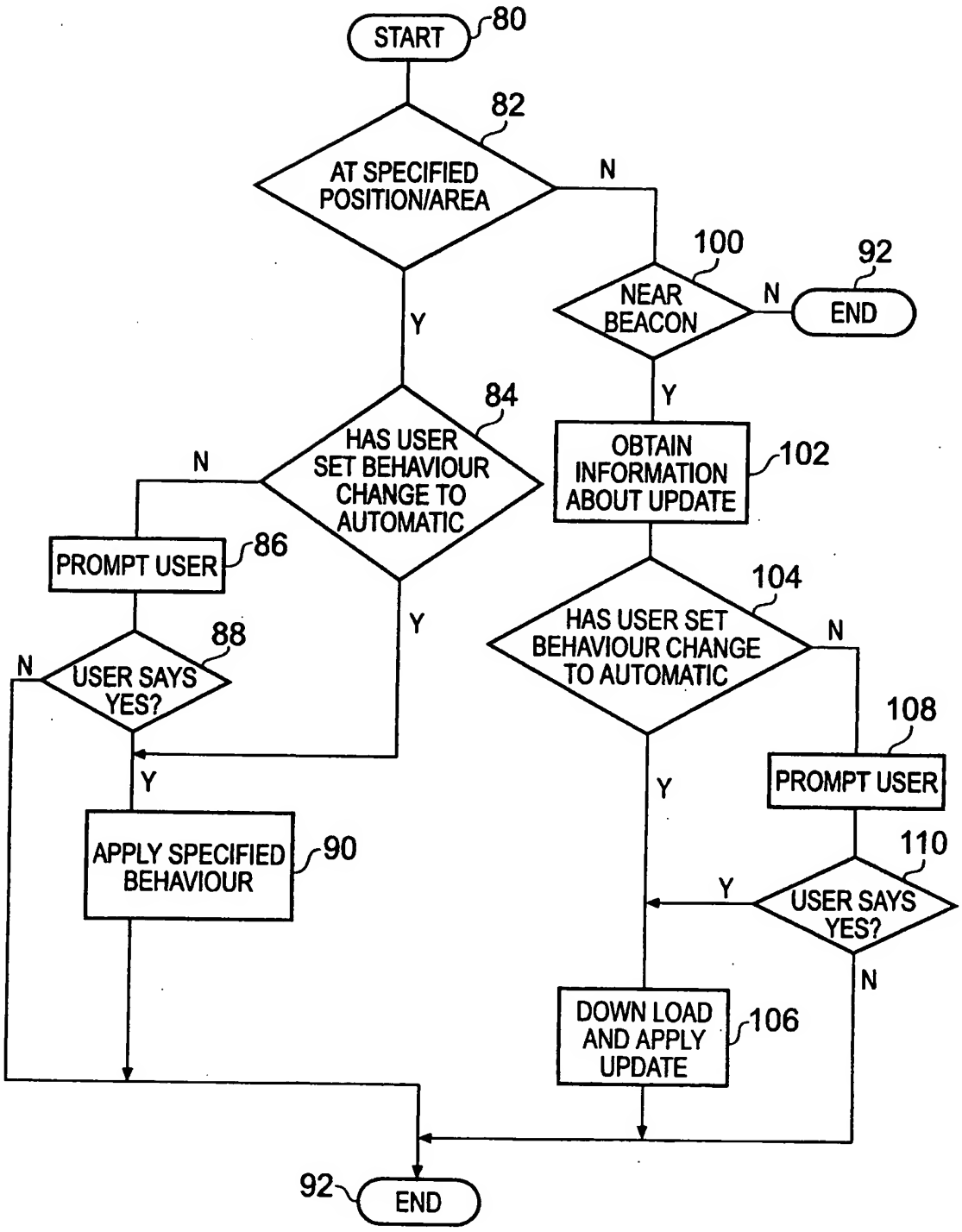
START
80
82
AT SPECIFIED POSITION/AREA
N
Y
100
NEAR BEACON
N
92
END
Y
84
HAS USER SET BEHAVIOUR CHANGE TO AUTOMATIC
N
Y
OBTAIN INFORMATION ABOUT UPDATE
102
PROMPT USER
86
104
HAS USER SET BEHAVIOUR CHANGE TO AUTOMATIC
N
88
USER SAYS YES?
N
Y
108
PROMPT USER
Y
APPLY SPECIFIED BEHAVIOUR
90
110
Y
USER SAYS YES?
N
DOWN LOAD AND APPLY UPDATE
106
92
END

Fig. 5

AN AUTONOMOUS CAMERA HAVING EXCHANGEABLE BEHAVIOURS

The present invention relates an autonomous camera having a mechanism for uploading and downloading camera behaviours.

The role of being a camera operator can often leave the user detached from the very event that they are trying to capture. Thus rather than participating in a family event, such as a wedding, attending a sporting event, or enjoying a holiday some people become so engrossed by the process of capturing these events on their camera that they don't truly participate in the event and merely observe the majority of the event through the view finder of the camera.

It has been proposed in the scientific literature to provide wearable cameras, see for example Starner, Schiele and Pentland, "Visual Contextual Awareness in Wearable Computing", 2nd International Symposium on Wearable Computers October 1998. Such a wearable camera is able to continually monitor the environment around a person and to capture scenes from it. Such a camera could, of course, be operated by the user but it is preferable that the camera is continually active and analyses the scenes that it has acquired in order to determine whether or not the image is "interesting". In this context "interesting" means that it would be of interest to the camera's owner.

Wearable cameras have no innate understanding of the environment around them. They therefore need to be trained to understand the visual (and other) clues presented to the camera in order to determine what images a user would like or prefer to be captured. The "rules" which a camera can apply in order to determine whether it should store an image can be considered as "behaviours". The behaviours that a camera should apply can vary depending on the position of the camera and the activity that the camera is viewing. Thus if the wearable camera were attached to a skier, then the chances are that interesting images would include those where other objects were reasonably close to the skier. However if the camera were attached to a hill-walker, then it is likely that panoramic views of scenery would be preferred. Furthermore, if a camera which had a behaviour suitable for skiing were to be used inside a shopping mall or supermarket then it is likely that almost all images would satisfy the condition of having objects sufficiently close for them to be considered interesting and hence the camera would be unlikely to show a sufficient level of

discrimination and would probably capture images relating to nearly all of the time that the wearer was in the supermarket environment.

A teachable camera is disclosed in US 5,227,835 assigned to Eastman Kodak Company. The teachable camera includes a template matching neural network which is responsive to inputs such as a focus sensor, an exposure sensor, a motion sensor and a flash control sensor, and also to a camera microprocessor, and which alters the performance of camera functions such as camera flash, shutter speed, lens focus, and aperture so that the camera characteristics are suited to the picture characteristics desired by the photographer. The neural network template can be altered by a rule based expert system executing on a personal computer.

Workers, such as Clarkson and Pentland in "Unsupervised Clustering of Ambulatory Audio and Video" proceedings of the International Conference of Acoustics, Speech and Signal Processing, Phoenix, Arizona, 1998, have disclosed a wearable camera which has used hidden markov models in order to determine the nature of the environment surrounding the camera. Thus, a camera having knowledge of the sort of images that it would see in a video store has successfully been demonstrated when it has entered another video store and is able to separate this environment from other events.

According to a first aspect of the present invention there is provided a camera having a behaviour memory for storing at least one behaviour for controlling automated image analysis and capture of images by the camera, and a behaviour controller for controlling at least one of input and output of behaviours to and from the behaviour memory.

It is thus possible to provide an automated camera where the behaviour of the camera may be modified. In particular, it is possible to provide a camera where an existing behaviour may be uploaded or saved for future use, and new behaviours may be downloaded into the camera.

As noted hereinbefore, a camera can be arranged to take pictures autonomously, or at least semi-autonomously. However the rules governing the operation of the camera may need to change depending on the event that is being observed by the camera. These rules can effect not only the aesthetic considerations concerning the scene viewed by the camera, but also technical considerations to be taken into account when capturing that scene. Suppose,

for example, that someone wearing a portable autonomous camera enters a tennis court. Supposing that the wearer is situated in the stands then it can be appreciated that one rule implemented within the camera may indicate that pictures are only to be captured, or subjected to further rule processing, when the court is framed in the central region of the picture captured by the camera. This could be achieved by requiring the overall image to have a high green content corresponding to grass at a lawn tennis court or a high red content corresponding to the playing surface of a clay court. Furthermore, the behaviour of the camera may be such that flash photography is inhibited when at a tennis court irrespective of the ambient level of illumination.

Advantageously the camera controller is responsive to indications of geographical position in order to cause modification of the camera behaviour to occur. The behaviour controller may, for example, be responsive to beacons placed in the vicinity of an event that may be observed or "consumed" by the camera and its wearer. Thus, returning to the example of the tennis match, beacons may be placed around the periphery of the tennis court in order to provide information to the camera that it is in the vicinity of the tennis court. The information provided by the beacons may include not only locational details, but may also include a voluntary behaviour and even a mandatory behaviour. The mandatory behaviour may, for example, be to cause the flash photography function of the camera to be inhibited during the time that the camera remains in communication with the beacon, until such time as the inhibition instruction is removed, or until a predetermined period of time has elapsed. These mandatory instructions may therefore be used to modify camera behaviour in accordance with an event organisers wishes. Thus, if the camera was at a wedding, for example a celebrity wedding, the bride may have concealed about her person a beacon which, depending upon her personal preferences, may either ensure that she is excluded from all images, or included in all images. The mandatory instructions may, of course, be associated with camera or user identifications such that different mandatory instructions can be sent to the different cameras. Thus authorised photographers may be able to program their cameras to ignore the mandatory instructions whereas all other users may be compelled to obey them.

Voluntary behaviours may also be made available to the camera. A behaviour is voluntary because the camera owner or user has a choice as to whether the camera operates in accordance with the voluntary behaviour or not. The user may set their camera such that it

automatically accepts voluntary behaviours and modifies its performance accordingly. Alternatively, the user may set the camera such that it alerts them that an offer of a voluntary behaviour has been made. The camera may then use a display or other communication device in order to provide a summary or commentary on the behaviour that has been offered. This gives the user sufficient information to decide whether to download the voluntary behaviour or not. Thus, in the case of a sporting event having beacons, the beacons may offer behaviour downloads that are intended to enhance the camera's performance to capture exciting or relevant images relating to that sporting event.

Additionally and/or alternatively the camera may be responsive to other positioning systems, such as a GPS transceiver which enables the camera to accurately determine its geographical position. The presence of a camera within a specific region, or the absence of the camera within a region, may be arranged to invoke one or more predetermined behaviours. Thus, if the camera determines from its geographic position that it is at sea, then it can download behaviours which serve to ensure that the camera does not capture endless images of waves rolling towards it, but instead becomes sensitised to other features. Such as capturing images aboard a ship or images of marine life. Furthermore the technical behaviour of the camera may also be varied and thus, for example, a polarising or other suitable filter may automatically be included within the optical path of the camera so as to reduce glare from the surface of the sea.

Different behaviours can thus be devised for different situations and positions. Whilst it may be feasible for a camera user to train the camera, it is far more convenient for the user to be able to download or otherwise import camera behaviour control programs or programs from other sources. Thus libraries of camera behaviours can be created and these libraries can be made accessible to users, either on a free or paying basis, as appropriate, in order that users can customise the response of their camera for particular situations. Such library downloads may be achieved by establishing communication with a behaviour library server over a mobile telecommunications device which may be external to the camera. An exemplary device would be a mobile telephone with an infrared link which could communicate with the camera via the camera's infrared link or via some other communications media such as a Bluetooth. Alternatively, the camera may have a telecommunications device integrated with it, or alternatively a telecommunications device may have a camera included within it. Mobile telephones having cameras integrated

therein are already commercially available. Furthermore other hand held computing devices such as personal digital assistants may also include the necessary functionality or have integrated therein both an imaging element and a telecommunications element.

The library may require the user or their camera to authenticate their identity by revealing a shared secret such as a password or even biometric data. An electronic camera is particularly suited for user identification based on iris pattern since the camera already includes a high resolution imaging device.

Advantageously a user may develop their own camera behaviour or modify camera behaviours and save these within the library, possibly within their own restricted space or to other behaviour stores. Such modified behaviours, or indeed behaviours in general, may include private sub-behaviours which a user may wish to be held secret and will not be disclosed. Such private or secret behaviours may be to seek to include or exclude particular people from image capture. Advantageously the use of secure computing platforms, such as platforms in accordance with the Trusted Computing Platform Alliance (TCPA) architecture may be used in order to ensure that secrets within the behaviours are not made available to an unauthorised users or cannot be subverted for other purposes. The TCPA specification can be found at www.trustedcomputing.org.

The instructions for controlling the camera behaviour are advantageously provided in machine independent format such that the same behaviour can be used on any suitably enabled camera irrespective of its manufacturer or internal computing devices. Thus the instructions could be written in a mark-up language, for example XML, and interpreted within the camera.

Advantageously the camera includes a long term image store for storing the images that it deems appropriate to capture. The camera may also include a short term image store, or buffer, in which the last few minutes of images are temporarily stored. Thus use of the buffer is advantageous as it enables a user to intervene to select a recently required image for storage. The buffer also enables the camera to perform analysis of the evolution of events in order to determine which of these events are likely to be interesting. Thus, for example, if a camera was operating with a news gathering or "reporter" behaviour and it determined from its image analysis that someone was lying on the ground, possibly with others in attendance or with blood being visible, then the camera could interrogate the

buffer memory in order to capture either a series of stills or a movie clip leading up to the relevant event.

Advantageously the camera is operable to generate still images and moving images of its environment.

Preferably the camera includes additional sensors. Such sensors may include a microphone, motion sensors, or even biometric sensors, such as a heart rate sensor and direction of look sensors in order to obtain cues from the camera wearer. The microphone can be used to associate an audio track with a moving or still image. However the microphone also provides an input to the behaviour processor in order to enable it to determine what images are likely to be interesting. Thus, the sound of a gunshot would be significant to the news gathering behaviour discussed above, whereas the sound of a ball on a racket and the cheering or roar of a crowd can be used by a "tennis match" behaviour in order to determine when a significant event may have occurred within a tennis match.

Motion of the user's head may also be used an input to the camera. Workers, such as Langton, Watt and Bruce "Do the Eyes have it? Cue to the Direction of Social Attention", Trends in Cognitive Neuroscience, 4(2):50-59, 2000, proposed four modes of observation used by humans. These include an "intentionality detector" which is a mechanism associated with self propelled motion such as reaching for a pen or moving towards a sofa and are detected in terms of a dyadic relationship (a desire or a goal) between a self propelled object and another one. An eye direction detector, or direction of gaze detector is also an important visual cue since users will generally fixate for longer on an item that is of particular interest to them. These user actions can give the camera information that it can use to determine if an "interesting" image currently exists. Other biometric data such as increased heart rate or skin conductivity may also be used as cues, for example to show that the wearer is excited.

The behaviours may also describe when a camera is most definitely not to take and store any images. Consider a person who has been wearing a camera all day for whatever reason. It is likely that during this time they will have needed to visit a lavatory. It would generally be considered undesirable to capture images inside the lavatory and hence specific behaviour models may be invoked in order to inhibit the image sensors of the camera, or lavatory beacons may be provided in or adjacent to such facilities. For

commonly used behaviours, such as the lavatory behaviour, the behaviours may be permanently stored within part of the behaviour memory such that they can be invoked at any time. Such behaviours may be associated with a code, such as a bar code or colour pattern code which may be displayed in or adjacent to lavatories in order to invoke the required behaviour. Thus it is apparent that visual beacons may also be used in order to cause a modification of camera behaviour.

According to a second aspect of the present invention there is provided a method of modifying the operation of a camera having a behaviour memory, the method comprising the steps of establishing communication with a behaviour repository and enabling the upload or download of behaviours from the camera.

According to third aspect of the present invention there is provided a method of modifying the behaviour of a camera, the method comprising the steps of monitoring the position of the camera or monitoring the presence of beacons, and in response to reaching a predetermined geographical position or being in the presence of a beacon implementing a new behaviour or alerting the user to the option of implementing a new behaviour.

According to a fourth aspect of the present invention there is a provided a behaviour server for storing a plurality of camera behaviours wherein the server is arranged to establish a communications channel with a camera, and to allow a camera user to select a camera behaviour for download to the camera.

According to a fifth aspect of the present invention there is provided a mobile device having a behaviour memory for storing at least one behaviour for controlling functionality of the device, and a behaviour exchange controller for controlling the exchange of behaviours with the behaviour memory, the behaviours being automatically modified in response to geographical position of the device or proximity to a behaviour beacon.

According to a sixth aspect of the present invention, there is provided a method of modifying the operation of a camera having a behaviour memory, the method comprising the steps of establishing communication with the camera, and sending a camera behaviour to the camera from a repository of camera behaviours.

The present invention will further be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 schematically illustrates the components inside an autonomous wearable camera constituting an embodiment of the present invention;

Figure 2 schematically illustrates communication between a camera and an event beacon;

Figure 3 illustrates the process for downloading behaviours from a behaviour library;

Figure 4 illustrates a menu presented to a user for selecting behaviours; and

Figure 5 illustrates a flow diagram for controlling geographical modification of camera behaviours.

A camera, generally designated 2, is shown in Figure 1. The camera comprises an image capture element 4, such as a charge coupled device array in association with an optical system 6. The optical system generally includes a lens 8 (which may be a compound lens) together with a lens focus mechanism and an aperture control mechanism, both of which are commonly provided on cameras and hence do not need to be described further here. The images captured on the charge coupled device array 4 are provided to a data processor 10. The data processor 10 provides an output to the aperture and focus controller in order to ensure that intensity and focus control are performed in accordance with known photographic principles. The data processor 10 also has bi-directional communication with a user interface 12 which typically comprises a liquid crystal display screen for displaying images and menus, together with cursor control and other buttons or switches to enable the user to input their desires and choices into the camera. The user interface 12 will also typically include a zoom control button and a shutter button. Thus the user interface is typical of that found in electronic cameras. The data processor 10 is also in communication with a behaviour memory 14 which can store data defining rules used to control the camera, and in particular to control automated image capture by the camera in response to detection by the camera's sensor (including its image capture components) of one or more events as specified by the rules. Such events may, for example, be specified sporting activities observed by the image capture apparatus or physical motion of the camera resulting from movement made by a person who is wearing the camera. The data

specifying the rules prescribing the actions/responses made by the camera to various events can be regarded as defining a "camera behaviour". The data processor 10 is arranged to control the import or export of camera behaviours to or from the behaviour memory 14, and also execute camera behaviours such that the camera can automatically capture images in accordance with the rules of a camera behaviour contained within the behaviour memory. The data processor is also in communication with a positioning determining device 16 which typically comprises a GPS module. The data processor 10 is also in communication with telecommunications devices 18 and 20. Telecommunication device 18 may, for example, be an infrared device, a Bluetooth device or other local communication device which can detect the presence of local behaviour beacons and communicate with them to perform the download, and optionally upload, of behaviours. The telecommunications device 20 is typically a mobile telephone component such that the camera can access remote libraries via the mobile telephone infrastructure. The data processor 10 is also communication with an image store 22 which is typically subdivided into a long term image store 24 and a short term image store 26. Images which have been captured for subsequent extraction are stored in the image store 24, whereas the temporary image store 26 functions as a working area such that the evolution of events may be analysed in order to determine whether they are "interesting". The data processor 10 is also connected to a data exchange bus 30 such that physical connection may be made between the camera and some other computing device for the download/extraction of stored images from the memory 24 or the modification of behaviours directly from the computing device (not shown). The data processor may also be connected to motion sensors 34 (such as inertial sensors or gyroscopes) so as to be responsive to user movement. In the present embodiment the processor 10 is also adapted to control the input/output facilities provided by the wireless (in this example Bluetooth) port 18, GPRS connection port 20 or the USB port 30 in order to load a camera behaviour into the behaviour memory. Thus the processor controls the input of behaviours to the behaviour memory 14, with behaviours usually being input pursuant to downloading them from an external source (which will be described in more detail subsequently), and the output of behaviours from the behaviour memory. Output of a behaviour includes the transfer of a behaviour to a behaviour store (ie uploading a behaviour), deletion of a behaviour, or depending on camera configuration the transfer of a behaviour to a further memory where

the rules are interpreted by the data processor such that the camera operates in accordance with the behaviour.

It should be noted that workers have already demonstrated that wearable cameras are capable of automatically detecting events. Detection of such events is usually performed using time series analysis methods such as the hidden Markov model. This model has been developed for use in voice recognition systems, see Lawrence R Rabiner, "A Tutorial on Hidden Markov Models and Selected Applications in Speech Recognition", proceedings of the IEEE, 77(2):257-286, 1989. Hidden Markov models have successfully been used, see for example Clarkson and Pentland, "Unsupervised Clustering of Ambulatory Audio and Video" (reference given hereinabove) and Yamato, Ohia, Ishii, "Recognising Human Action in Time Sequential Images using Hidden Markov Models" proceedings of Computer Vision and Pattern Recognition conference, pages 379-385, 1992. The hidden Markov model is a stochastic space model of the temporal structure of the input variables. These models are usually trained on example patterns. Thus, in one particular mode of operation a hidden Markov model could be trained to detect the characteristic head motion and audio intensity during a tennis match and another to detect the situation when a point was scored, which is most likely characterised by the typical cheer of the crowd and the relatively steady head motion. When the camera is at a tennis match (which can be categorised as a place or an event) and these two hidden Markov models (and perhaps others) are matched against the stream of sensor data, for example data from the microphone 32, from gyroscopes 34 or from other user sensors (not shown) which may interface with the camera via the communications device 18, the camera can infer when a particular even has occurred.

Each hidden Markov model can be used as a classifier yielding a probability that a particular situation that they have been trained on is occurring. By running several such classifiers in parallel and comparing the relative probabilities the camera can detect situations of interest. Thus, in the situation described above where the roar of the crowd is detected, the second Markov model would yield the highest probability when a point has recently been scored and the camera could then save the last 5 or 10 seconds of video from the buffer 26 to the long term store 24.

In accordance with one embodiment of the present invention the various models, whether in their entirety or whether in a parametised form can be transferred to and from the behaviour memory 14. Figure 2 schematically illustrates an arrangement in which a user 40 wearing the camera 2 is travelling in a direction indicated by the arrow A. During this motion the user passes a model beacon 44 which stores a model therein and has a data processor and a communications device such that the beacon 44 can establish communication with the camera 2. The beacon 44 could simply repeatedly transmit a descriptor of the model and the model itself using a high bandwidth interface such that the entire download of the model could be easily accomplished during the duration of the time that the use is in communication range with the beacon 44. Alternatively the beacon 44 may be in communication with a model server 46 via a further communications path 48. Thus the beacon 44 serves as a local point of presence for the server 46. In this scenario the camera uses the beacon 44 to establish communication with the server 46. Such a scenario is useful where the server owner 46 wishes to authenticate the camera and user's identity (which may be stored in a further memory area within the camera 2) in order that the server owner can seek payment from the camera user before authorising download of a modified behaviour to the camera.

A process where the camera authenticates with a remote server, either via the cellular telephone infrastructure or via a local point of presence is shown in Figure 3. The process commences at step 60 where the camera and server establish secure communications with one another and then authenticate identities, for example by exchange of a secret which had been defined during a prior registration process with the server. Following authentication, control passes to step 62 where a menu, or a hierarchical menu of options is displayed to the user. Such a menu can be displayed by use of the LCD device incorporated within the camera. The user can use the cursor buttons provided on the camera in order to select a desired behaviour from the menu at step 64. Control then passes to step 66 where the appropriate behaviour is downloaded from the server (which acts as a library or a repository of camera behaviour) to the camera. The download may include a hand shaking process such that data integrity and completion of the download can be verified. Once the download is complete, control optionally passes to step 68 where the user's account is debited and from then to step 70 where the process is terminated by performing a hand off on the communications channel and closing the channel. Due to the

limited capabilities for displaying text of the LCD device of a camera, a simple drop down memory of the type shown in Figure 4 may be used. Thus in Figure 4 sports behaviours have been selected and the options "tennis", "golf", and "skiing" are provided. The user uses cursor control buttons on the back of the camera to highlight the appropriate option and then manipulates a further camera button in order to confirm their choice. Of course, a camera may have a behaviour memory of sufficient size to store several behaviours. In such a case the user may use a menu, of the type shown in Figure 4, for example, to select a behaviour from the ones stored in the behaviour memory.

As noted hereinbefore, in what is either an alternative manner of selecting/downloading a behaviour, or a way of augmenting a behaviour already selected or downloaded the camera can be arranged to change its behaviour in response to geographical position. Figure 5 illustrates a flow chart for performing this. Control is commenced at step 80 and then immediately passes to step 82 where the GPS system is interrogated to discover the current position of the camera. This is then compared with position descriptors associated with behaviours held in the behaviour memory 14 (which could be either a modification of a behaviour already stored in the memory 14, or downloading anew behaviour). If the camera is in a specified area or region as defined by the behaviour descriptors, then control passes to step 84 where a test is made to see whether the user has set the camera to enable automatic update of behaviour. If step 84 determines that automatic update has not been set, then control passes to step 86 where the user is informed that a new behaviour is appropriate and from then on control is passes to step 88 where the user is asked whether the new behaviour should be implemented. If the user indicates that it should be, then control is passes to step 90 where the new behaviour is applied, otherwise control is passed to step 92 which represents the end of the procedure. Returning to step 84, if behaviour update has been set to occur automatically, then control passes directly from step 84 to step 90.

Returning to step 82, if the user is not in a specified predefined area for which they have predefined the behaviour to be used, then control passes to step 100 where the communications device 18 is interrogated to see if the camera is near a beacon. Furthermore recent video images may also be scanned in order to determine if a visual beacon has been detected. If the camera is not near a beacon then control is passed to step 92, otherwise control is passed to step 102 where information about the update is obtained

from the beacon, if such information is available. From step 102 control is passed to step 104 where a test is made to see if the user has set the camera for automatic update. If the user has set the camera for automatic update, then control is passed to step 106 where the behaviour update is downloaded and applied, and from there control passes to step 92. Returning to step 104, if the camera has not been set to automatically update its behaviour, then control is passed to step 108 where a prompt is issued to the user and from then to step 110 where a test is made to see whether the user has authorised the update. If the user authorises the update then control is passed to step 106, otherwise control is passed to step 92.

The procedure shown in Figure 5 can be repeated periodically in order to check whether the camera behaviour should be modified.

Rather than merely relying on the proximity of a beacon the user can also use the camera interface in order to force a connection via the mobile telephone component to a suitable enabled server 46 in order to invoke the procedure shown in Figure 3 or indeed to instruct the camera to upload its current behaviour to a space reserved for that user.

The camera can be arranged to modify its behaviour model, either through unsupervised teaching (see Clarkson and Pentland) or by supervised learning wherein the user participates in training of the camera. The camera can therefore associate a confidence value with the behaviour implemented within the camera. The camera can upload both the behaviour and the confidence value when the camera owner wishes to store the behaviour. The upload process can be further modified such that automatic and periodic uploads of camera behaviour occur. Uploads of behaviours may be inhibited when the confidence value is below a predetermined threshold, or such uploads may require specific user intervention. The behaviour and image analysis could be performed in a processing unit remote from the image capture components. Thus, if sufficient bandwidth was available, a remote camera could transmit its video back to a computing device which could then perform the analysis described herein. Alternatively, a camera could store video into a storage device, and the video store could be analysed at a later date again to automatically select images using the processes described herein.

The camera may require the user to identify themselves, for example via a password or biometric data (iris scanning can be implemented within a camera) before implementation

of exchange (upload or download) of camera behaviours is authorised. This security mechanism system may be implemented by the data processor.

It is thus possible to provide a mechanism for exchanging camera behaviours with an autonomous camera.

CLAIMS

1. A camera having a behaviour memory for storing at least one behaviour for controlling automated image analysis and capture of images by the camera, and a behaviour controller for controlling at least one of input and output of behaviours to and from the behaviour memory.

2. A camera according to claim 1, wherein the behaviour controller is adapted to control input of a behaviour from a source external of the camera.

3. A camera according to claim 2, wherein the behaviour controller is adapted to input a behaviour from a source external of the camera by obtaining data from the external source to modify a behaviour within the behaviour memory.

4. A camera according to claim 1, wherein the behaviour controller is adapted to input a behaviour modifying a behaviour within the behaviour memory by means of a learning process involving a user.

5. A camera according to claim 1, wherein the behaviour controller is adapted to control output of a behaviour by implementing a behaviour within the behaviour memory.

6. A camera as claimed in claim 1, wherein the behaviour controller is responsive to indications of geographical position.

7. A camera as claimed in claim 6, wherein the behaviour controller is responsive to beacons placed at events or places to indicate that the camera is at an event or at a specific place.

8. A camera as claimed in claim 7, in which the behaviour controller downloads a behaviour from the beacons.

9. A camera as claimed in claim 8, in which prior to implementing or downloading a behaviour, the behaviour controller checks with one of the user and a download rule base.

10. A camera as claimed in claim 6, in which the behaviour controller is responsive to a GPS positioning system and wherein behaviours can be invoked in response to the position of the camera.

11. A camera as claimed in claim 1, in which the camera can download behaviours from a behaviour library.

12. A camera as claimed in claim 11, in which the behaviour library requires registration or payment and the camera must authenticate with a library access control prior to being able to obtain behaviours from the library.

13. A camera as claimed in claim 1, in which the camera includes a behaviour interpreter.

14. A camera as claimed in claim 1, in which the camera can upload behaviours to a behaviour library.

15. A camera as claimed in claim 1, wherein the behaviour controller includes a security system for preventing unauthorised export or initiation of behaviours.

16. A camera as claimed in claim 15, in which the security system requires a user to identify themselves by revealing a shared secret to the security system in order to initiate use or export of a behaviour.

17. A camera as claimed in claim 15, in which the security system is responsive to biometric data of the user.

18. A camera as claimed in claim 1, further including an image processor for analysing scenes viewed by the camera in accordance with instructions contained in the behaviour and on the basis of the analysing determining whether to capture the scene.

19. A camera as claimed in claim 1, wherein the camera is portable.

20. A camera as claimed in claim 1, wherein the camera is wearable.

21. A camera as claimed in claim 1, further including a telecommunications device for exchanging data with one of a local beacon and a remote computing device.

22. A camera as claimed in claim 1, in which the camera is capable of modifying its behaviour, and associating a confidence value with the behaviour, and in which the camera uploads the confidence value with the behaviour.

23. A camera as claimed in claim 22, in which upload of a behaviour is inhibited if the confidence value is below a predetermined threshold.

24. A camera as claimed in claim 22, which an upload of behaviour requires user intervention if the confidence value is below a predetermined threshold.

25. A behaviour server for storing a plurality of camera behaviours, wherein the server is arranged to establish a communications channel with a camera, and to allow a camera user to select a camera behaviour for download to the camera.

26. A behaviour server as claimed in claim 25, wherein the user can upload a camera behaviour to the server.

27. A method of modifying the operation of a camera having a behaviour memory, the method comprising the steps of monitoring the position of the camera or monitoring the presence of beacons, and in response to reaching a predetermined geographical position or being in the presence of a beacon implementing a new behaviour or alerting a user to the option of implementing a new behaviour.

28. A behaviour beacon arranged to transmit a signal that can be received and interpreted by suitably configured mobile devices for invoking a change in operation.

29. A mobile device having a behaviour memory for storing at least one behaviour for controlling automated image analysis and capture of images by the mobile device, and a behaviour exchange controller for controlling the exchange of behaviours with the behaviour memory.

30. A method of modifying the operation of a camera having a behaviour memory, the method comprising the steps of establishing communication with a repository of

camera behaviours and uploading or downloading behaviours from the behaviour memory.

31 A method of modifying the operation of a camera having a behaviour memory, the method comprising the steps of establishing communication with the camera, and sending a camera behaviour to the camera from a repository of camera behaviours.

Application No:	GB 0314968.9	**Examiner:**	Matthew Males
Claims searched:	1, 25 & 29 - 31	**Date of search:**	16 December 2003

Patents Act 1977 : Search Report under Section 17

Documents considered to be relevant:

Category	Relevant to claims	Identity of document and passage or figure of particular relevance	
X	1, 21, 25, 29 - 31 at least	WO 02/041273 A1	VISISERVE LTD - whole document but see abstract; pg 12, line 13 onward; Fig 1.
X	1 & 29 at least	WO 03/009074 A1	HONDA GIKEN - whole document but see abstract; pg 7, line 12 onward, esp pg 8, lines 8 - 16; Figs 1, 2.
A	-	US 20020086271 A1	MURIGA at al - whole document but see pg 2, paras [0032] & [0033]; Fig 1.

Categories:

X	Document indicating lack of novelty or inventive step	A	Document indicating technological background and/or state of the art.
Y	Document indicating lack of inventive step if combined with one or more other documents of same category	P	Document published on or after the declared priority date but before the filing date of this invention
&	Member of the same patent family	E	Patent document published on or after, but with priority date earlier than, the filing date of this application

Field of Search:

Search of GB, EP, WO & US patent documents classified in the following areas of the UKC[V]:

H4F

Worldwide search of patent documents classified in the following areas of the IPC[7]:

H04N

The following online and other databases have been used in the preparation of this search report:

WPI, EPODOC, JAPIO, INSPEC